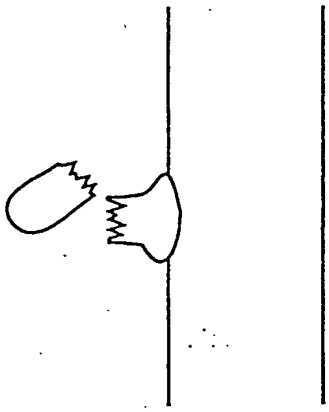

Fig. 1a

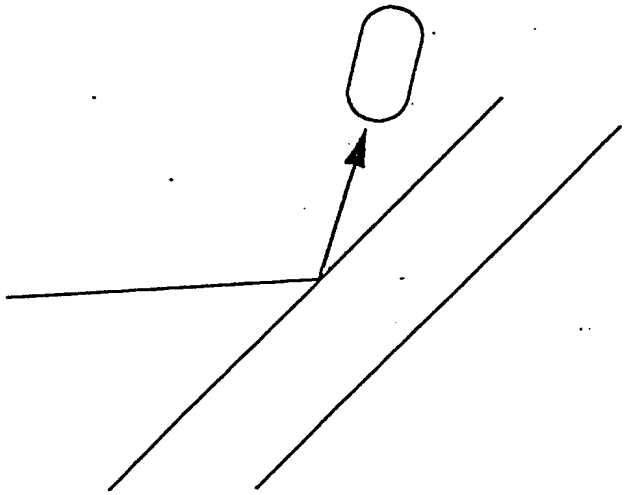

Fig. 1b

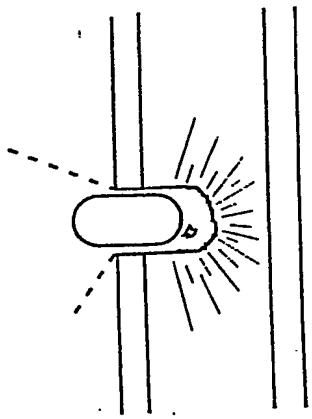

Fig. 1c

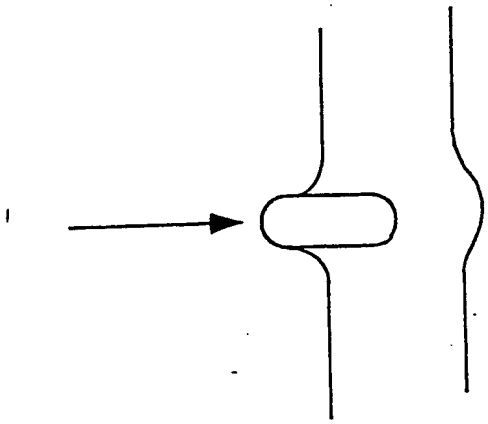

Fig. 1d

Test No.	Target				Areal Density	FS[b]: Before Impact			FS: After Penetration				Specific Energy Absorbed[c]
	Material(s)	Mesh (Yarns/in.)	Thickness per Ply (in.)	No. of Plies	(g/cm^2)	Mass (g)	Velocity (m/s)	K.E. (J)	Velocity (m/s)	K.E. (J)	K.E. Lost (J)	K.E. Lost (%)	($J/g/cm^2$)
20	Zylon	30X30	≈0.006	1	0.0130	25	79	78	61.5	47.5	30.5	39	2346
26	Zylon	30X30	≈0.006	1	0.0130	25	82.5	85	63	49.5	34.5	41	2654
23	Zylon	30X30	≈0.006	1	0.0130	25	80	80	35.5[f]	20[f]	60	75	1366
	UHMW Polyethylene Felt		≈0.13	1	+0.0309								
22	Zylon	30X30	≈0.006	1	0.0130	25	82	84	Did not Penetrate[g]		84	100	≥1123
	UHMW Polyethylene Felt		≈0.13	2	+0.0618								

[b] FS means fragment simulator.

[c] Specific energy absorbed (SEA) is defined as energy absorbed per unit areal density.

[f] The impactor did not penetrate the felt; however, the impactor, surrounded by the felt layer, completely penetrated the fabric.

[g] Only partial penetration was obtained in this test—the impactor, surrounded by the felt, remained lodged in the hole in the fabric.

Fig. 2

Test No.[a]	Target				Areal Destiny (g/cm^2)	FS[b]: Before Impact			FS: After Penetration				Specific Energy Absorbed[c] ($J/g/cm^2$)
	Material(s)	Mesh (Yarns/in.)	Thickness per Ply (in.)	No. of Plies		Mass (g)	Velocity (m/s)	K.E. (J)	Velocity (m/s)	K.E. (J)	K.E. (J)	Lost (%)	
13	Zylon	45 X 45	≈0.011	1	0.0219	25	78	76	29	10.5	65.5	86	2990
19[d]	Zylon	45 X 45	≈0.011	2	0.0438	25	113	160	64	51.5	108.5	68	2477
20	Zylon	30 X 30	≈0.006	1	0.0130	25	79	78	61.5	47.5	30.5	39	2346
26	Zylon	30 X 30	≈0.006	1	0.0130	25	82.5	85	63	49.5	34.5	41	2654
25	Zylon	35 X 35	≈0.0075	1	0.0158	25	77.5	75	59	43.5	37.5	42	2373
24	Zylon	40 X 40	≈0.009	1	0.0185	25	79	78	49.5	30.5	48.5	61	2622
29	Zylon	40 X 40	≈0.009	4	0.0740	96	79	300	27.5	36.5	263.5	88	3560
32	Zylon	40 X 40	≈0.009	6	0.111	96	79	300	Did not Penetrate[e]		300	100	2702
23	Zylon	30 X 30	≈0.006	1	0.0130	25	80	80	35.5[f]	20[f]	60	75	—
	UHMW Polyethylene Felt		≈0.13	1	+0.0309								
22	Zylon	30 X 30	≈0.006	1	0.0130	25	82	84	Did not Penetrate[g]		84	100	—
	UHMW Polyethylene Felt		≈0.13	2	+0.0618								

a Tests 13 and 19 were performed and reported during the previous reporting year.
b Fragment simulator.
c Specific energy absorbed (SEA) is defined as energy absorbed per unit areal density.
d Data from this test are questionable due to the excessive pitch, debris from the aluminum honeycomb momentum trap traveling ahead of the impactor, and some PBO fibers from the back (22° orientation) layer breaking at the corner of the clamping rod, and thus likely reducing the absorbed kinetic energy.
e The impactor penetrated only the first of the six layers.
f The impactor did not penetrate the felt; however, the impactor, surrounded by the felt layer, completely penetrated the fabric.
g Only partial penetration was obtained in this test—the impactor, surrounded by the felt, remained lodged in the hole in the fabric.

Fig. 3

Test No.	Vl-de-o	Test Date (1998)	Target Material	Target Fabric Type (Yarn Count)	No. Plies	Areal Density (g/cm²)	Gripped Edges[a] No. Yarns:	Gripped Edges[a] ll to	Gripped Edges[a] Width (in.)	Penetrator Type[b]	Penetrator Orientation[c]	Stroke Rate[d] (in./s)	Data Rate (ms)	1st Yarn Break Stroke (in.)	1st Yarn Break Load (lb)	Failure Stroke[e] (in.)	Maximum Load (lb)	Maximum Modulus (lb/in.)	Yarns Broken (Warp+fill)	Work Done[f] (In.-lb)	Work Done[f] (J)	Per Broken Yarn (J)	SEA (J/g/cm²)
P-22	√	4/23	Zylon	35X35 Weave	1	0.0158	4	W & F	5.0	29-g FB	45°	0.075	10	0.488	153	0.757	153	742	33+38= 71	42	5	0.07	300
P-23	√	4/23	Zylon	35X35 Weave	1	0.0158	4	W & F	5.0	29-g FB	45°	0.075	10	0.697	493	1.035	634	2545	35+36= 71	220	25	0.35	782
			Zylon	Felt #2	2	0.0160	Not gripped			Total Areal Density = 0.0318													
P-26	√	4/28	Zylon	35X35 Weave	1	0.0158	4	W & F	5.0	29-g FB	45°	0.075	10	0.672	400	1.023	484	1778	32+37= 69	208	23	0.34	987
			Zylon	Felt #2	1	0.0080	Not gripped			Total Areal Density = 0.0238													
P-28	√	4/29	Zylon	35X35 Weave	1	0.0158	2	F	5.0	29-g FB	45°	0.075	10	0.687	260	1.330	277	954	26+42= 68	174	20	0.29	1244
P-29	√	4/30	Zylon	35X35 Weave	1	0.0158	2	F	5.0	29-g FB	45°	0.075	10	0.781	398	≈2.70	506	1585	2+33= 35	687	78	2.22	2441
			Zylon	Felt #2	2	0.0160	Not gripped			Total Areal Density = 0.0318													
P-30	√	5/7	Zylon	35X35 Weave	1	0.0158	2	F	5.0	Rounded FB	45°	0.075	10	0.612	214	1.232	214	829	29+41= 70	120	14	0.19	858
P-31	√	5/7	Zylon	35X35 Weave	1	0.0158	2	F	5.0	Rounded FB	45°	0.075	10	0.834	463	≈2.70	478	1301	2+31= 33	661	75	2.26	2348
			Zylon	Felt #2	2	0.0160	Not gripped			Total Areal Density = 0.0318													
P-35	√	5/13	Zylon	35X35 Weave	1	0.0158	2	F	5.0	29-g FB	0°	0.075	10	0.667	288	1.051	288	1127	1+53= 54	106	12	0.22	758
P-36	√	5/14	Zylon	35X35 Weave	1	0.0158	2	F	5.0	29-g FB	0°	0.075	10	0.764	388	≈3.4	587	1773		943	107		3350
			Zylon	Felt #2	2	0.0160	Not gripped			Total Areal Density = 0.0318													
P-37	√	5/20	Zylon	35X35 Weave	1	0.0158	2	F	5.0	25-g FS-sh	0°	0.075	10	0.572	240	0.767	269	974	----------	81	9	----	579
P-38	√	5/20	Zylon	35X35 Weave	1	0.0158	2	F	5.0	25-g FS-sh	0°	0.075	10	0.792?	377?	>2.2	532	1475		433	49		1538
			Zylon	Felt #2	2	0.0160	Not gripped			Total Areal Density = 0.0318													

[a] W = warp yarns; F = fill yarns.

[b] FS = fragment simulator; FB = fan blade

[c] The angle between the direction of the warp yarns and the longest dimension of the penetrator's impact end (e.g. the blade direction).

[d] Tests involve constant stroke rate to complete penetration, except where marked "c" (cyclical loading) or "i" (interrupted before full penetration).

[e] Data is for complete penetration, except for interrupted tests (marked "i"), where data is at maximum before interruption.

[f] Equals the area under the load-deflection curve.

Fig. 4

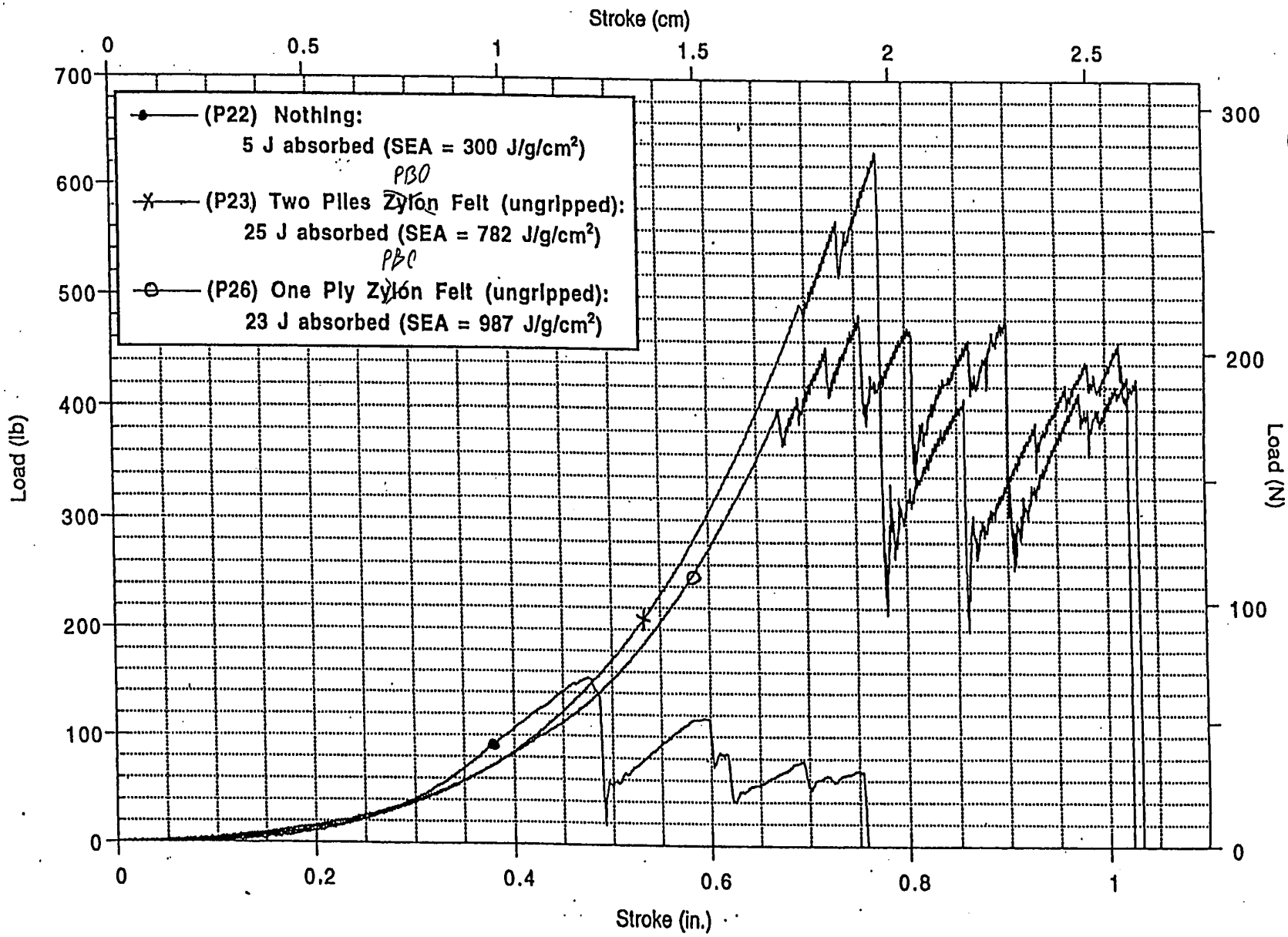

Fig 5

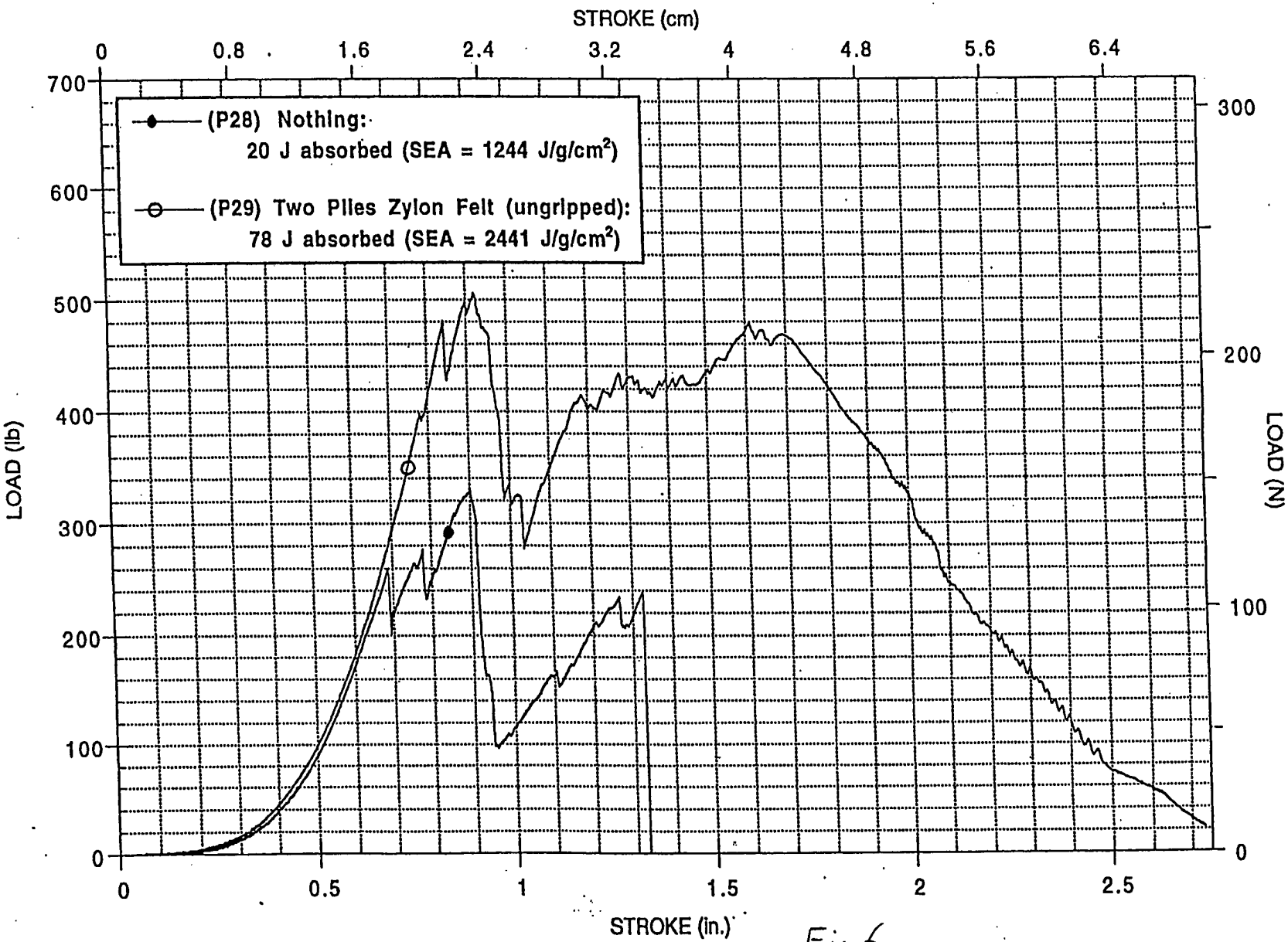
STROKE (cm)
0
0.8
1.6
2.4
3.2
4
4.8
5.6
6.4
700
600
500
400
300
200
100
0
LOAD (lb)
300
200
100
0
LOAD (N)
(P28) Nothing:
20 J absorbed (SEA = 1244 J/g/cm²)
(P29) Two Plies Zylon Felt (ungripped):
78 J absorbed (SEA = 2441 J/g/cm²)
0
0.5
1
1.5
2
2.5
STROKE (in.)

Fig. 6

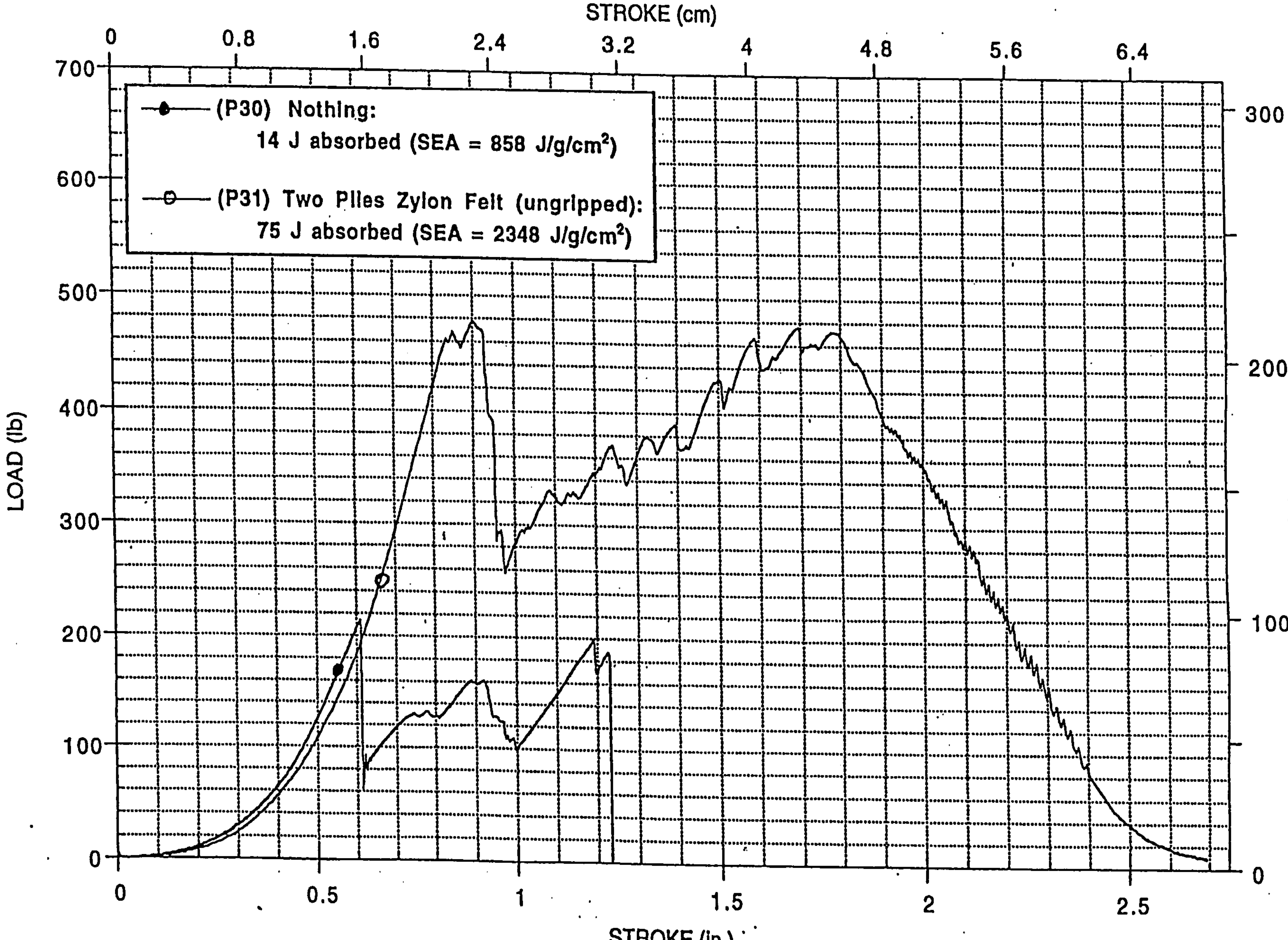

Fig 7

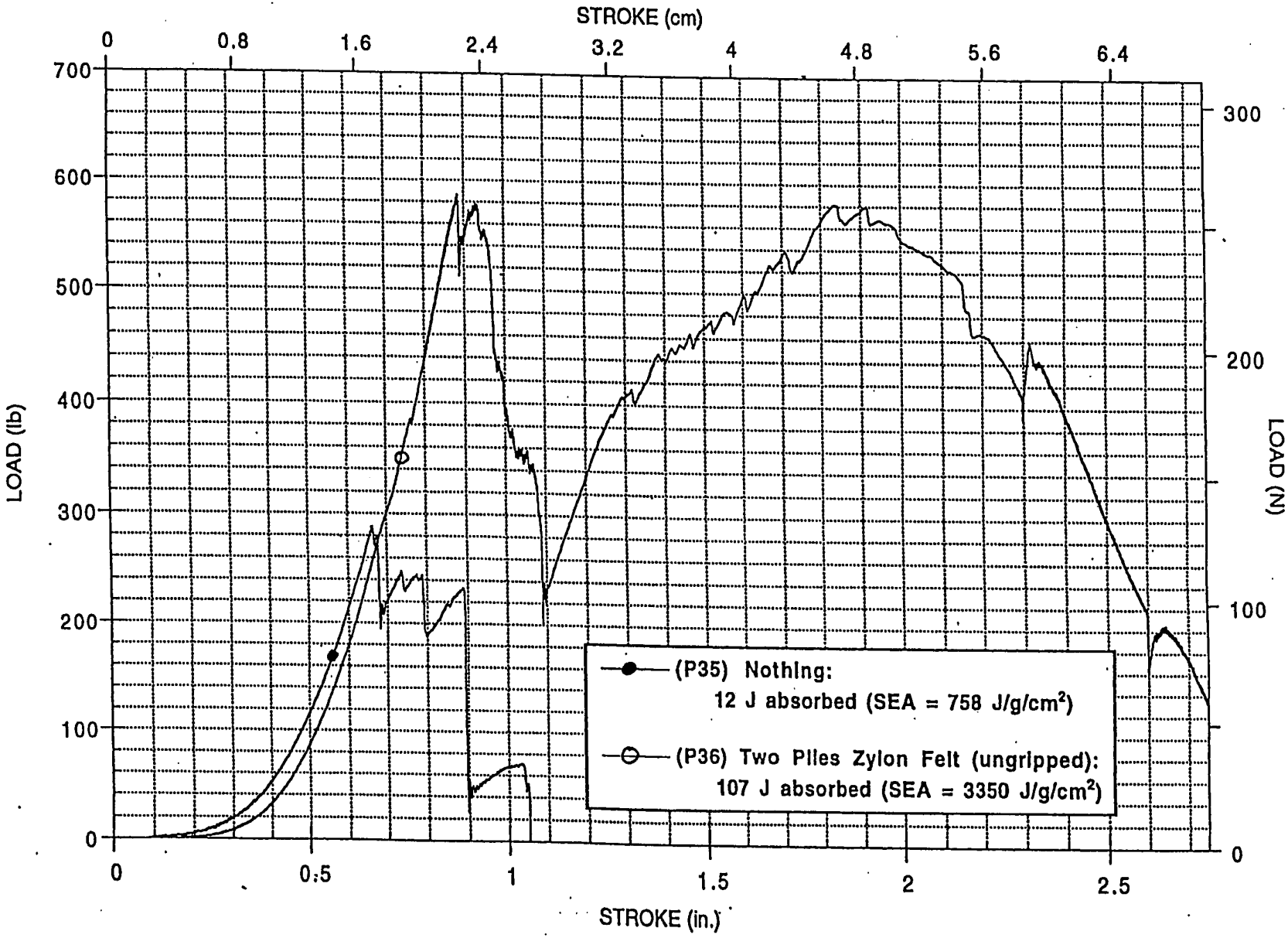

Fig. 8

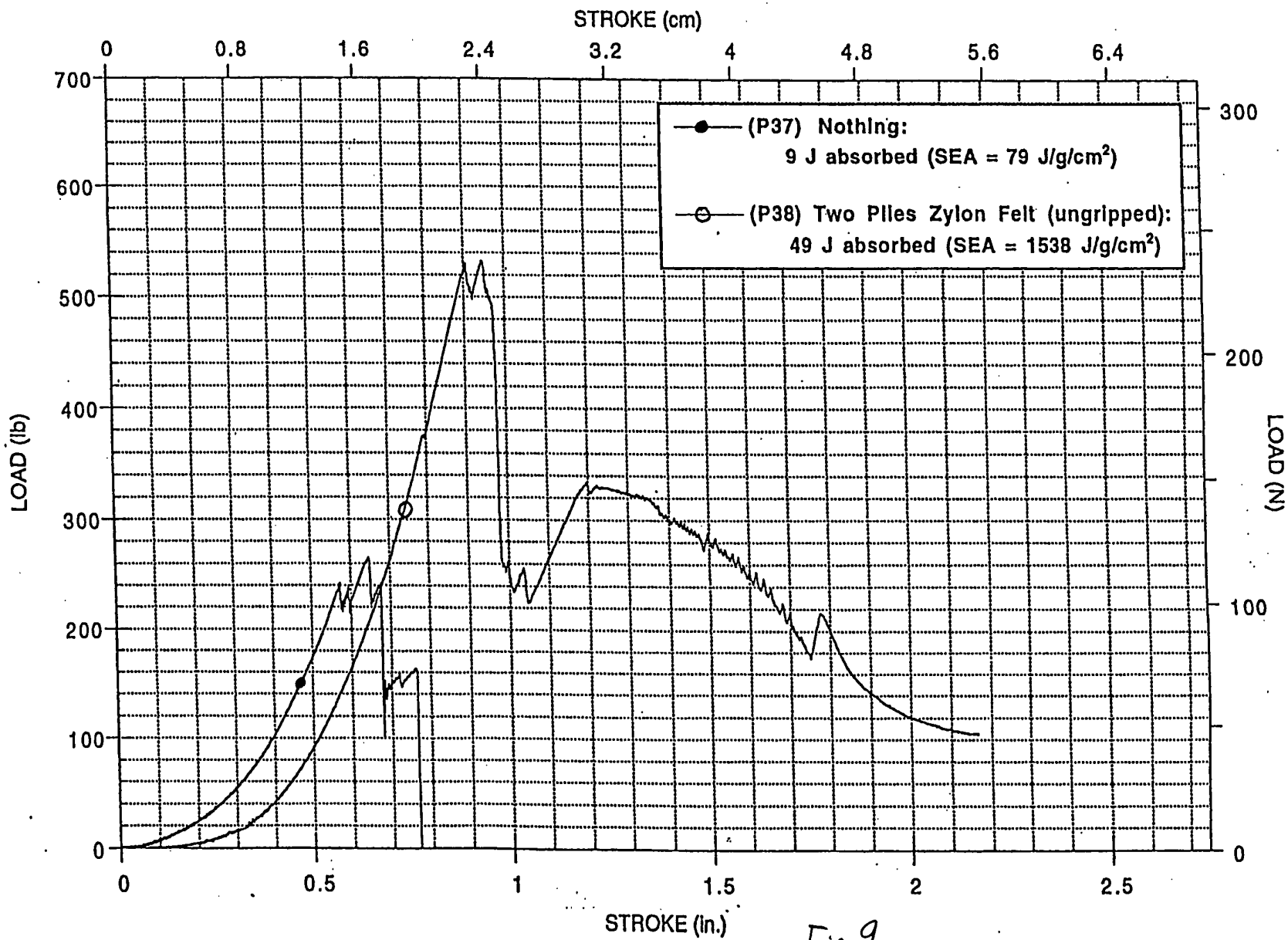

Fig. 9

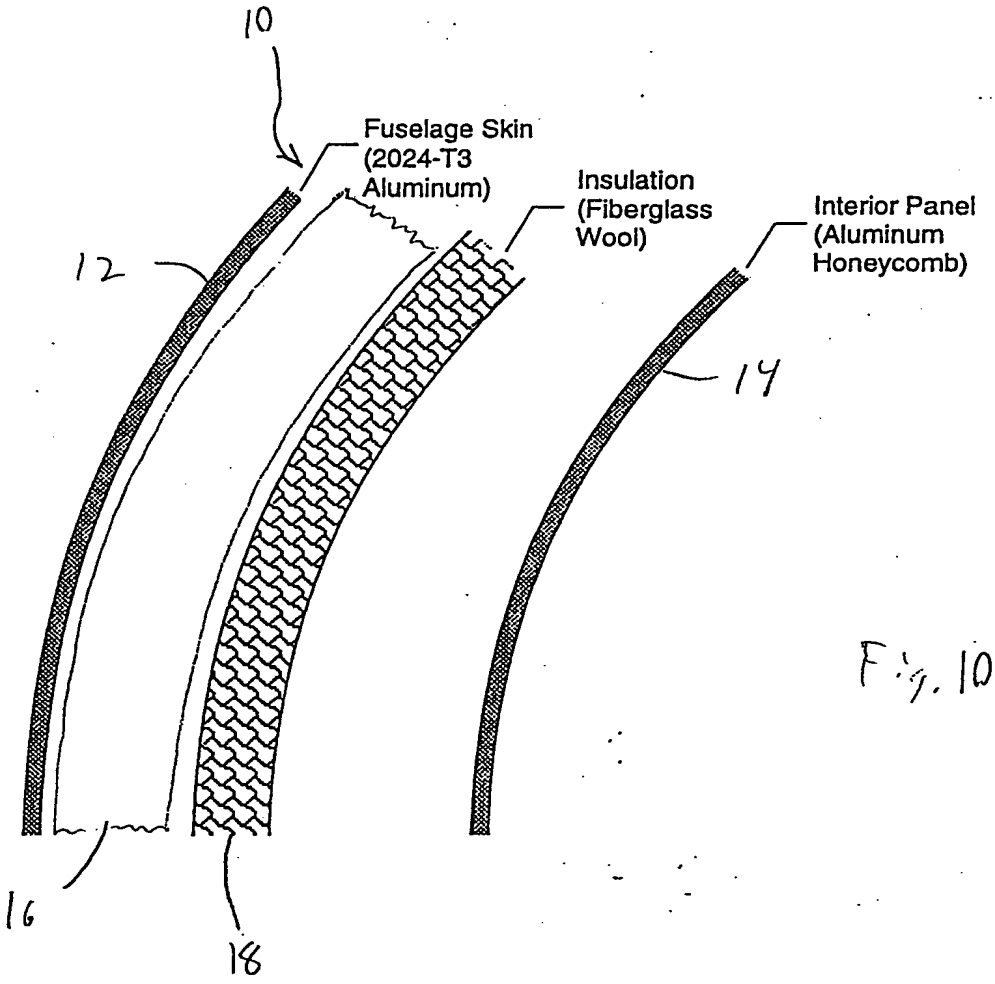
10
Fuselage Skin
(2024-T3
Aluminum)
Insulation
(Fiberglass
Wool)
Interior Panel
(Aluminum
Honeycomb)
12
14
16
18

Fig. 10

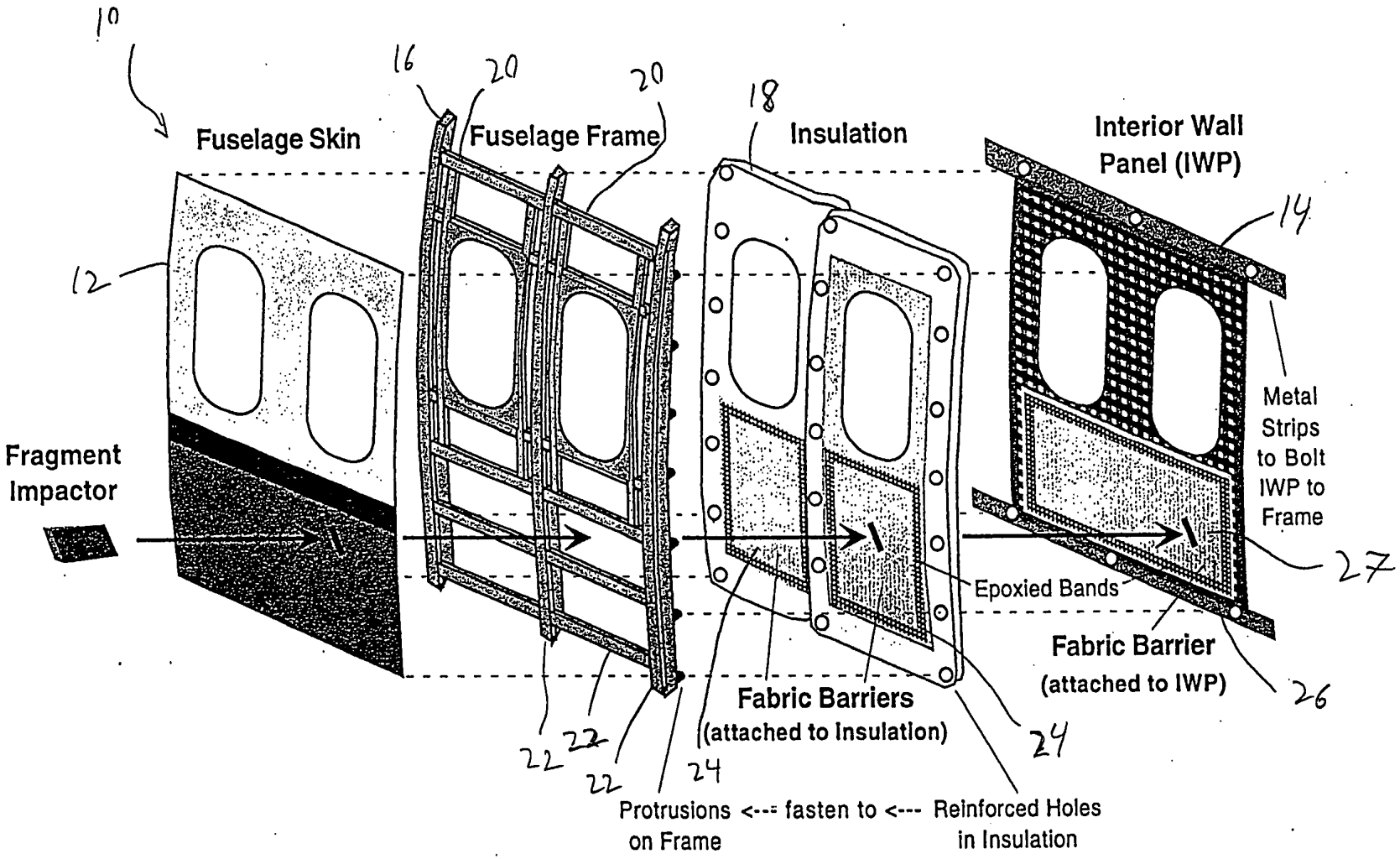

Fig. 11

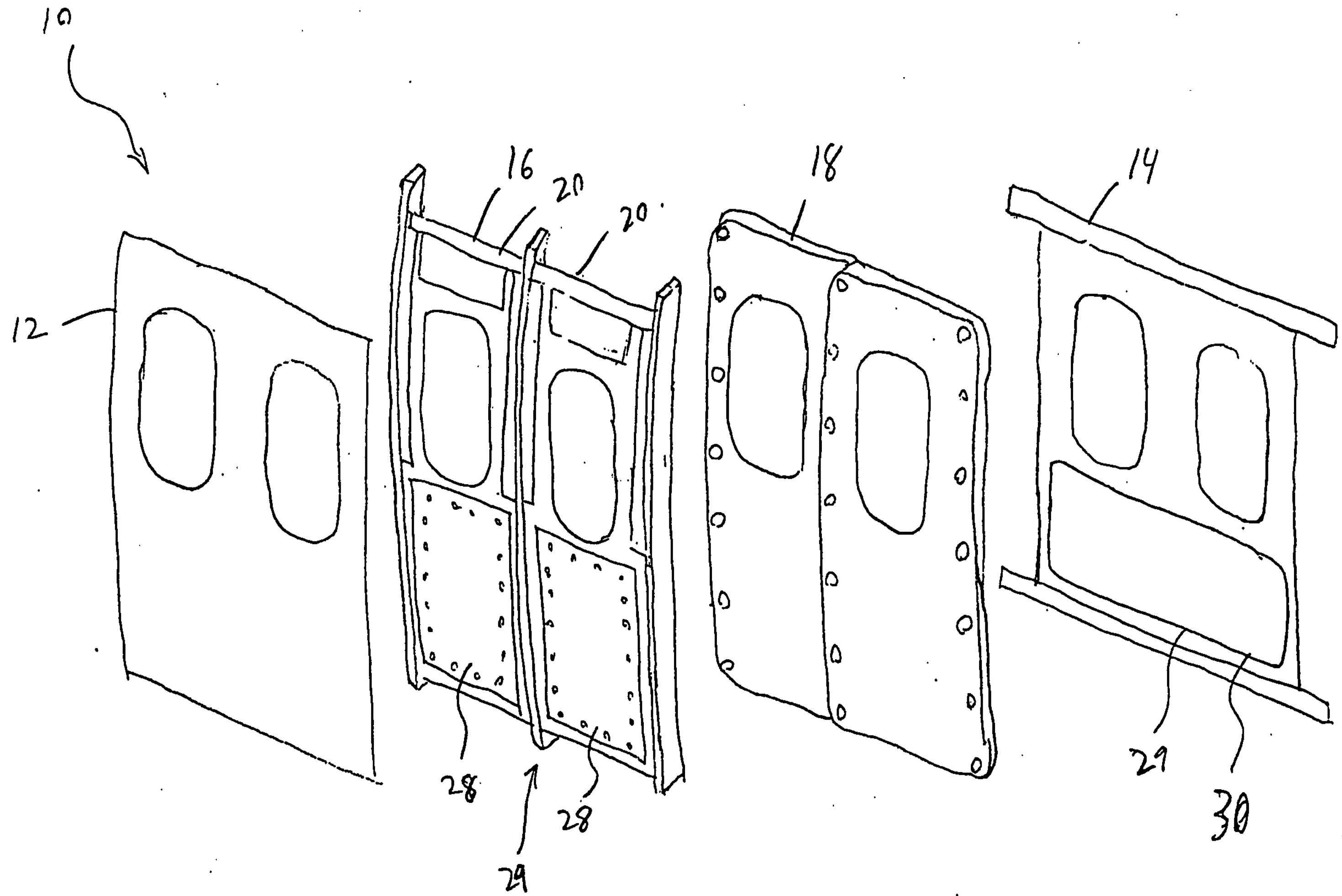

Fig. 12.

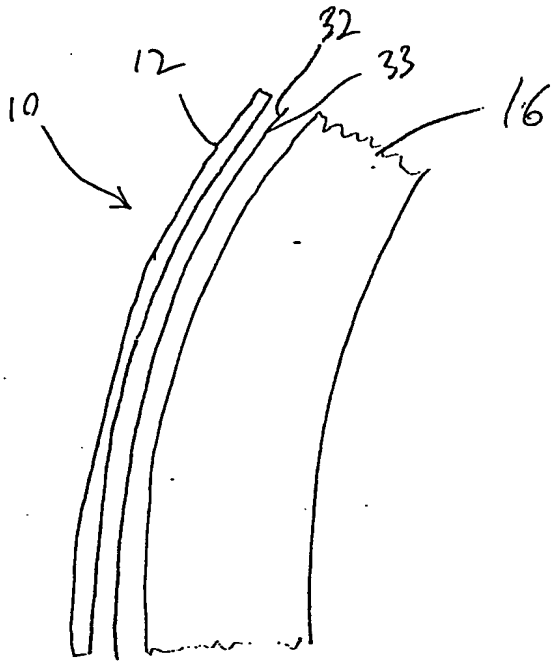

Fig. 13

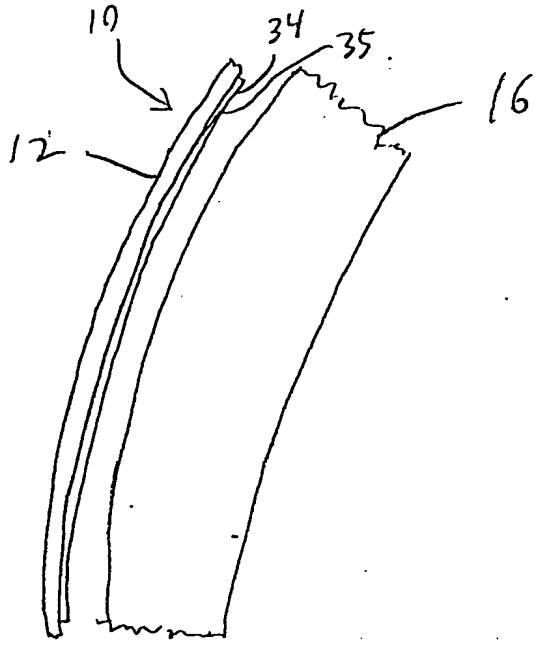

Fig. 14

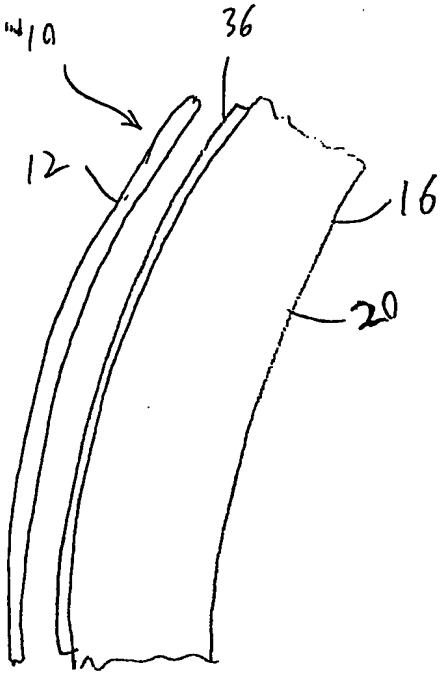

Fig. 15

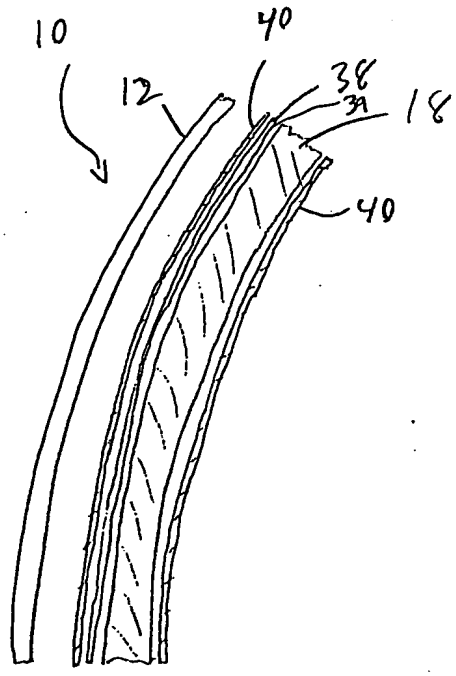

Fig. 16

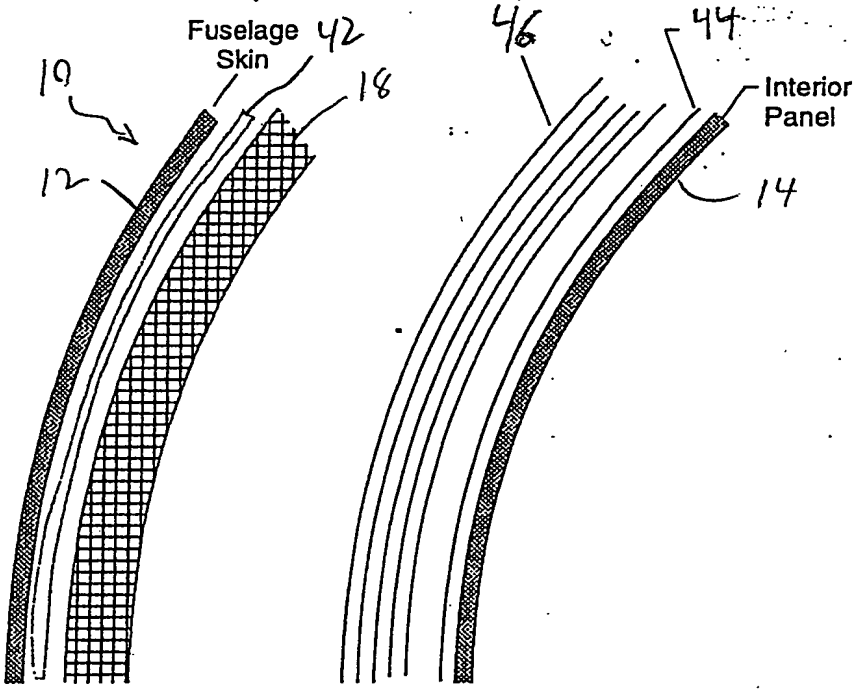
Fuselage Skin
42
10
18
12
46
44
Interior Panel
14

Fig. 17

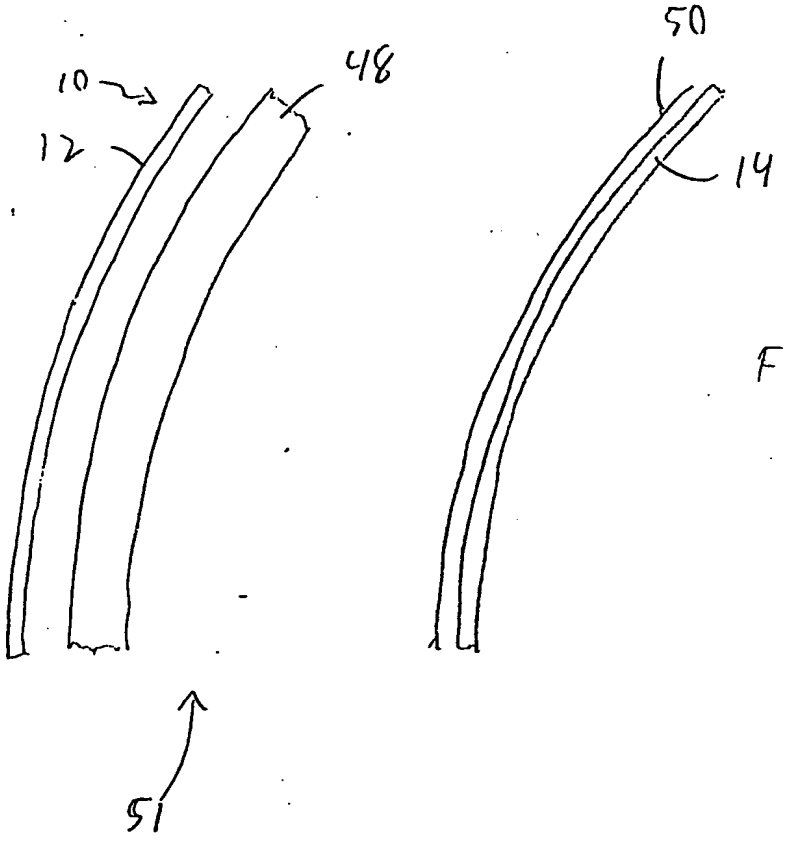
10
48
12
50
14
51

Fig. 16

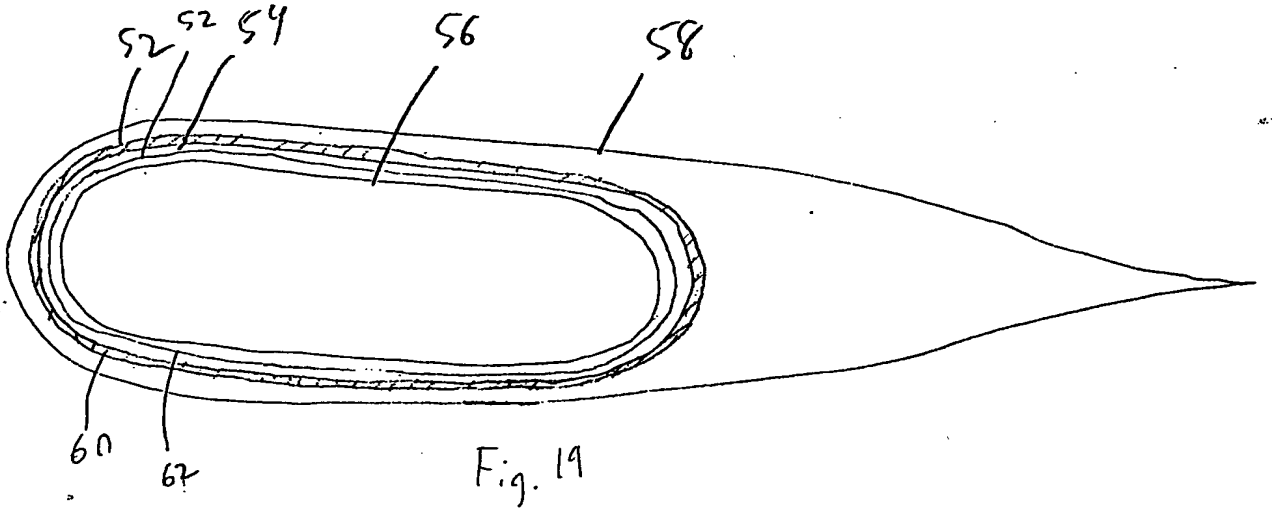

Fig. 19

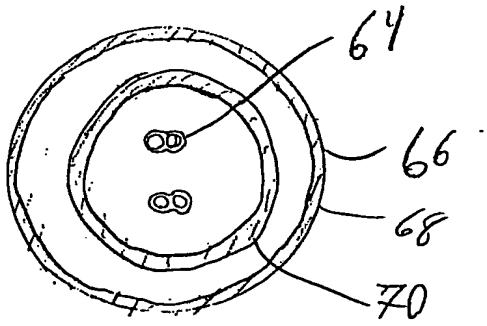

Fig. 20

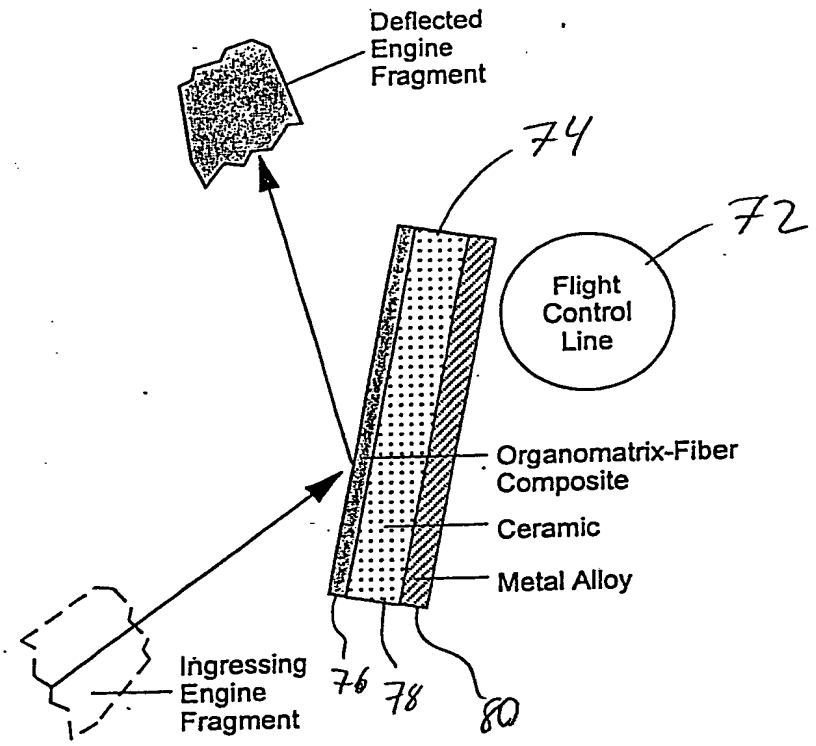
Deflected
Engine
Fragment
74
72
Flight
Control
Line
Organomatrix-Fiber
Composite
Ceramic
Metal Alloy
Ingressing
Engine
Fragment
76
78
80

Fig. 21

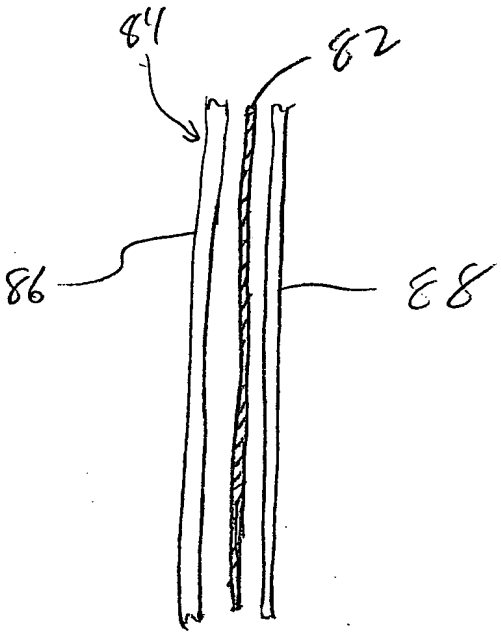

Fig. 22

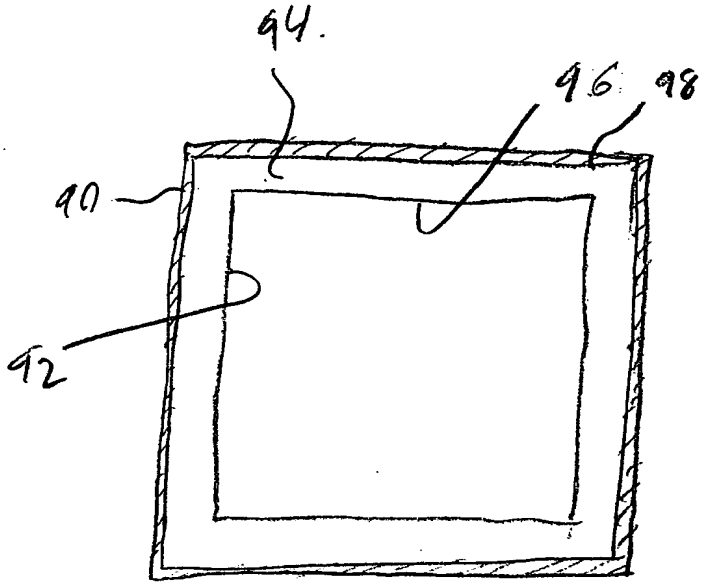

Fig. 23

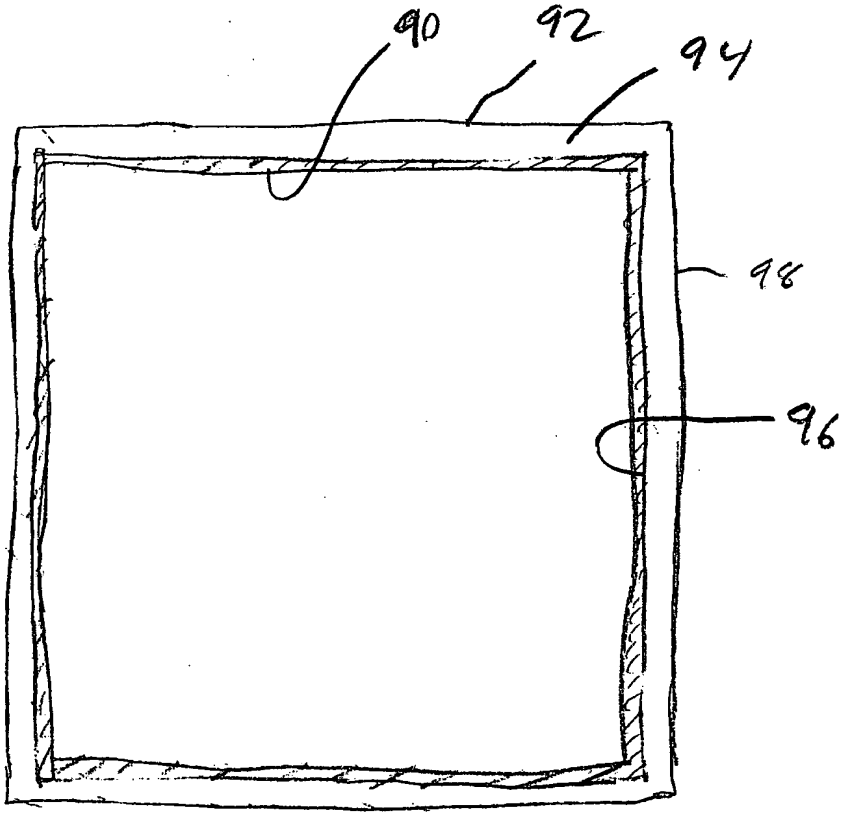

Fig 24

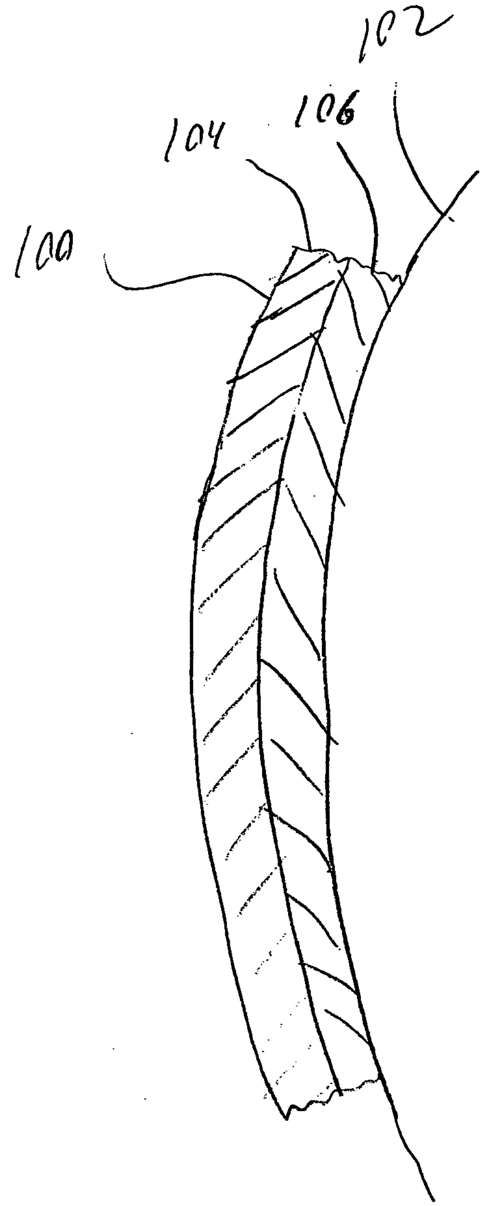

Fig. 25